Heavy Flavor via Leptons at PHENIX

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New Results

Single muons from Cu+Cu

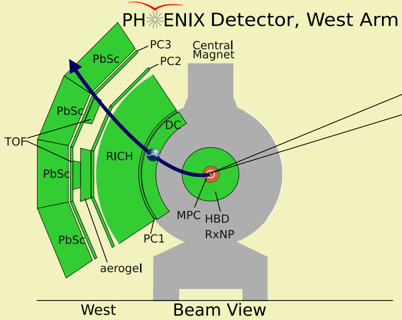
Update to electron background

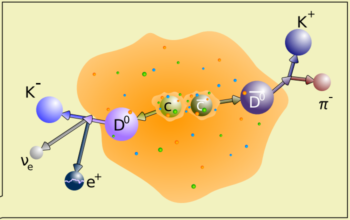
Direct Reconstruction

$D^0 \rightarrow K + \pi^{\pm}$

$D^0 \rightarrow K + \pi^{\pm}\pi^0$

Difficult without accurate vertex measurement ($c\tau \sim 123\mu m$)





Indirect Measurement

Measure contribution from semileptonic decays of heavy flavor to electron spectra

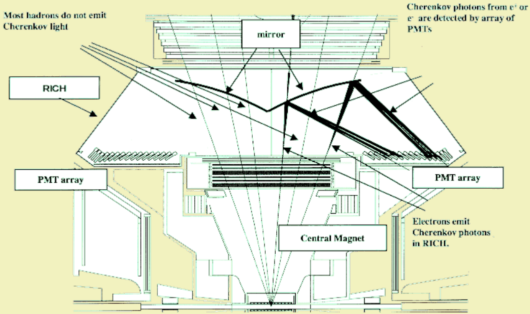
Both single and pair spectra

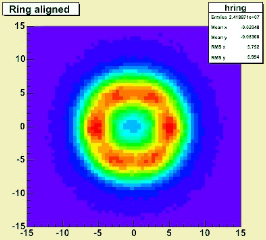
Detectors

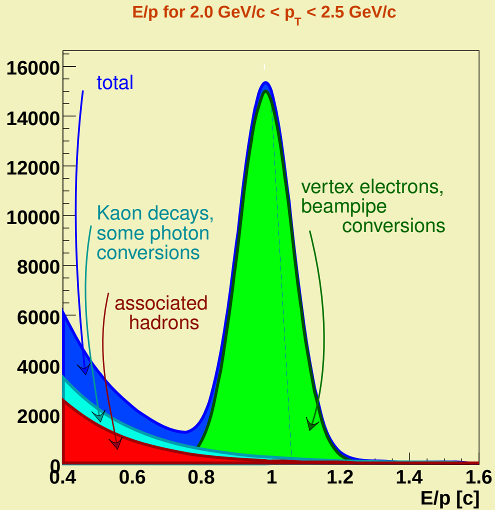
Tracking in drift chamber. Track matching to RICH and EMC.

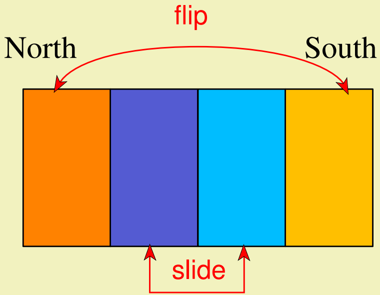
Ring size/shape in RICH

E/p distribution from the EMC and DC





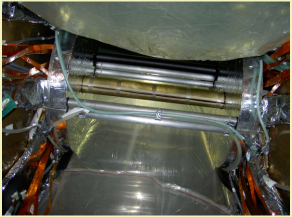




Hadronic Background

Some hadronic tracks are randomly associated with a ring in the RICH. These are statistically subtracted by swapping the north and south sides of the RICH in software.

The finite D and B meson decay length does not significantly affect E/p.



Method

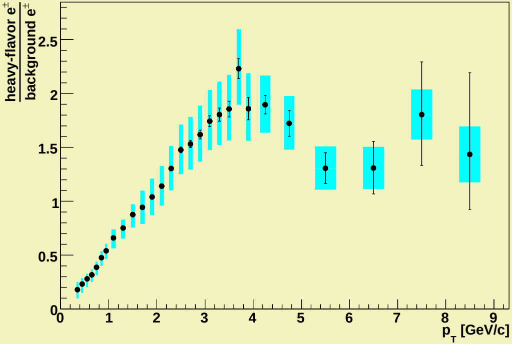
Add material of known thickness around the beampipe and compare the electron spectra with and without the material installed.

$$N_{HF} = \frac{R_\gamma N_{inc} - N_{inc}^{converter}}{R_\gamma - 1}$$

Works best at low p_T where photonic sources are significant

Limited by statistics of converter run

Converter method is used to normalize the cocktail method



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Method

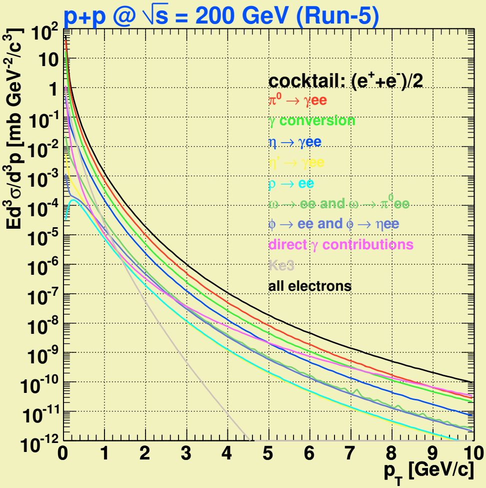
Most relevant background sources are <u>measured</u>.

Decay kinematics and photon conversion rate are simulated.

Background cocktail is subtracted from inclusive spectrum.

Performs well at high p_T where signal/background is large.

Not limited by statistics.



J/ψ, Υ, and Drell-Yan have been added.

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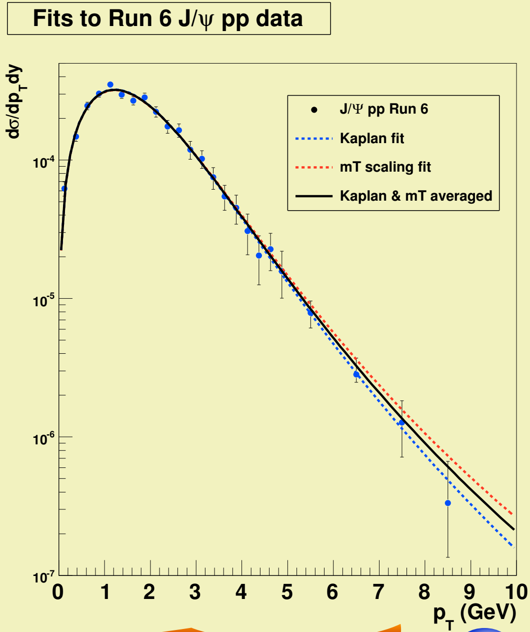


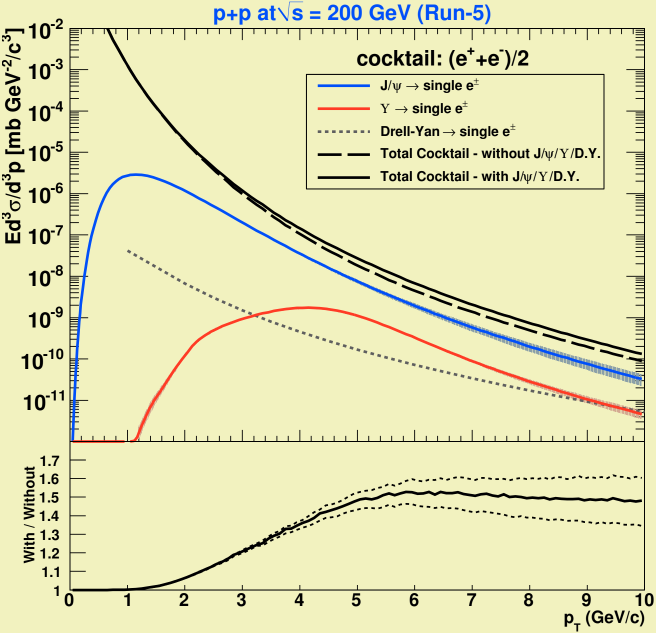
Kaplan: $$\frac{dN}{dp_T} = \frac{p0 \times p3 \times p_T}{\left[1 + (p_T/p1)^2\right]^{p2}}$$

m_T scaling:

$$E\frac{d^3\sigma}{dp^3} = A\left(e^{-(ap_T + bp_T^2)} + p_T/p0\right)^{-n}$$

replace p_T by $\sqrt{(p_T/c)^2 - m_{\pi^0}^2 + m^2}$

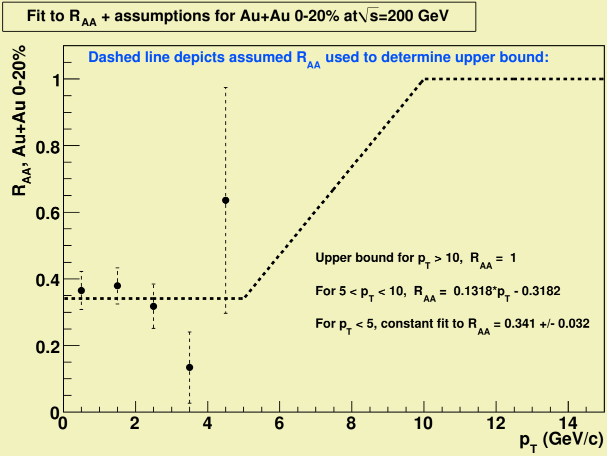
Cocktail Method: New Additions



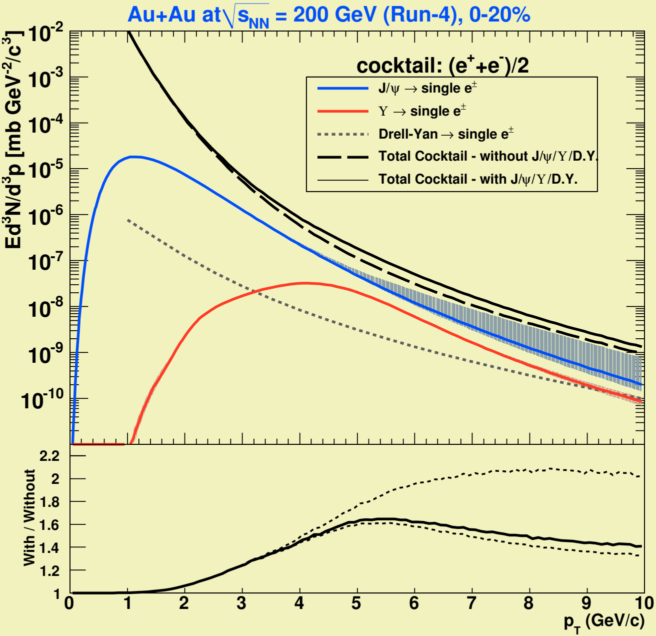
Cocktail Method: New Additions

Upper bound: For $p_T < 5$ GeV/c, use fit to constant R_{AA} value. For $5 < p_T < 10$ GeV/c, assume linear increase of R_{AA} to unity.

Lower Bound: Use $p+p$ lower bound, scaled by $N_{\rm coll}$ and R_{AA}.



Cocktail Method: New Additions



$p + p$ Spectra: Total Heavy Flavor

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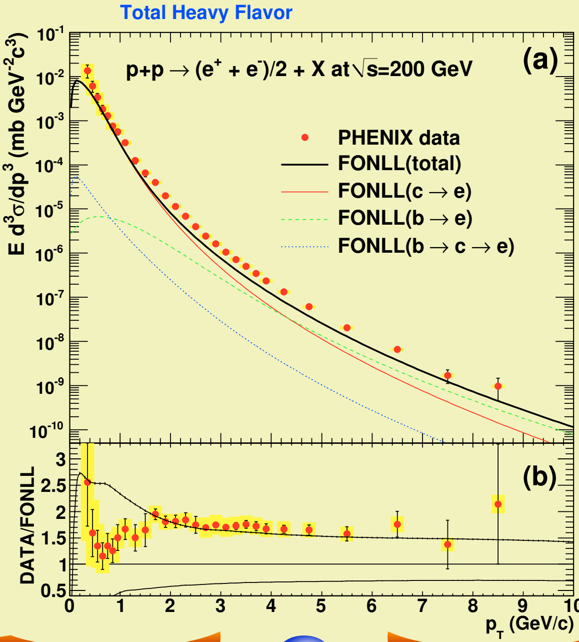
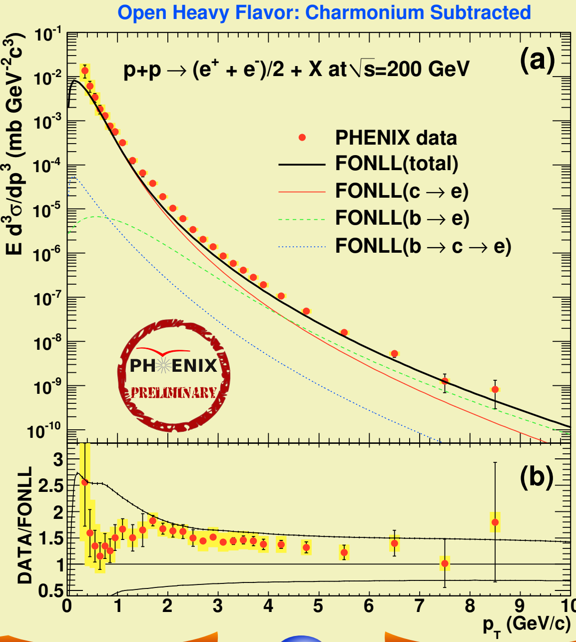


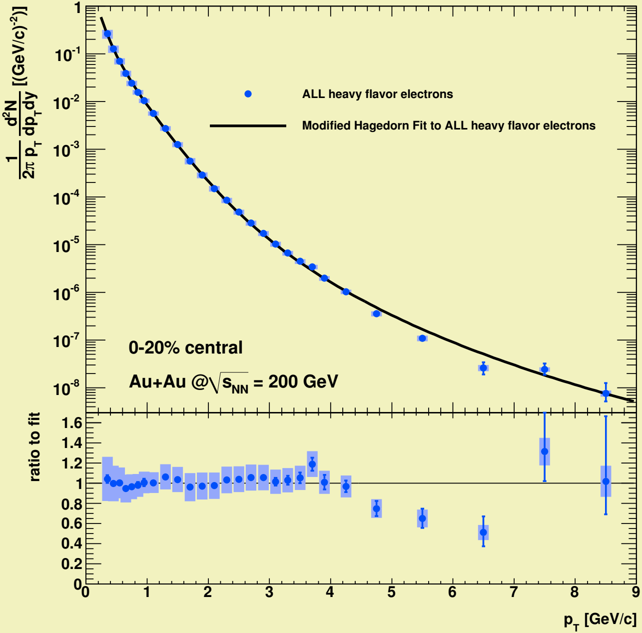
$p + p$ Spectra: OPEN heavy Flavor

PHENIX

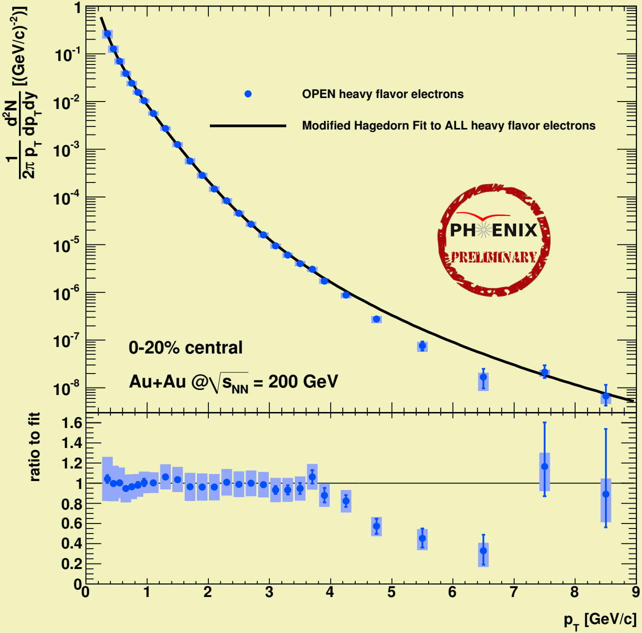


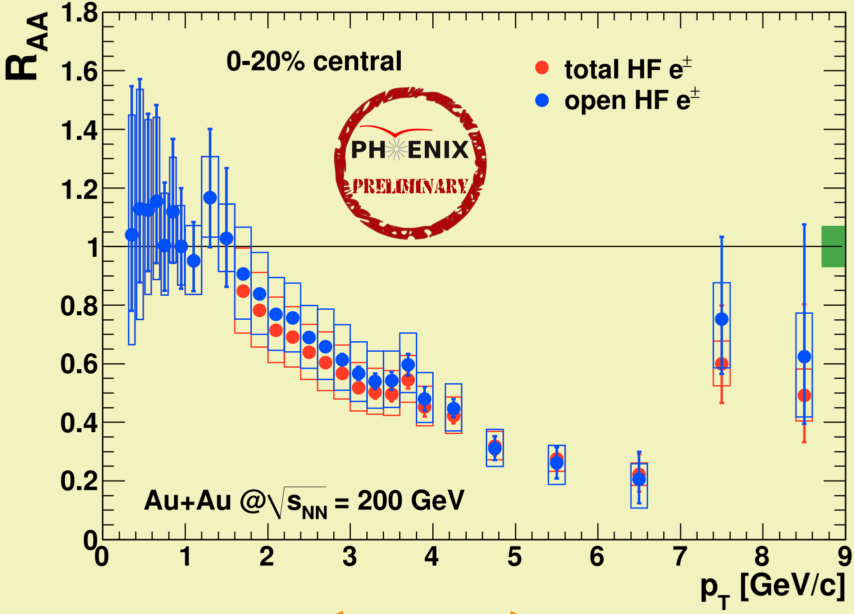
Au+Au 0-20% Spectra: Total Heavy Flavor

PHENIX



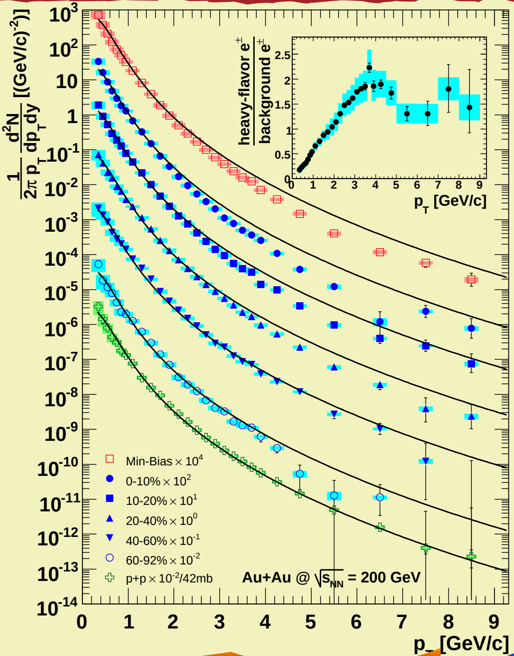
Au+Au 0-20% Spectra: OPEN heavy flavor

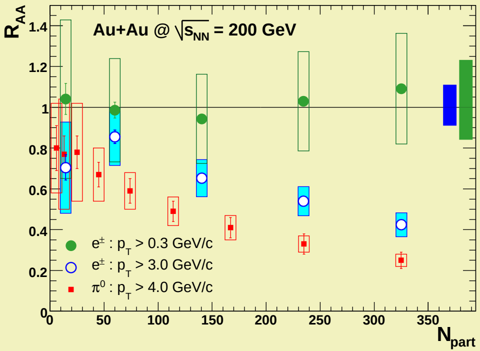




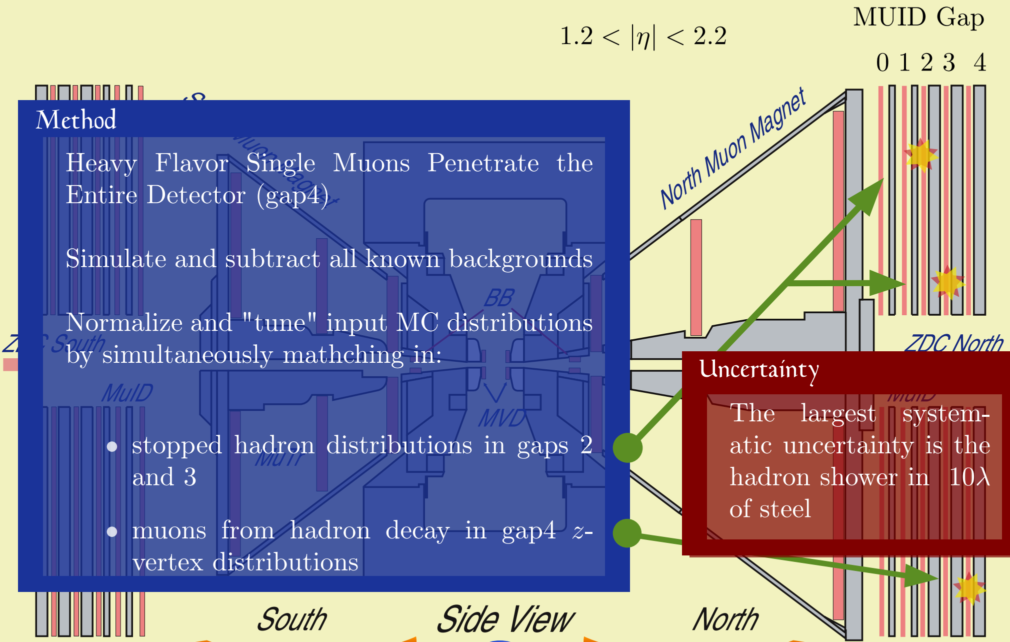
R_{AA}
0-20% central
total HF $e^{\pm}$
open HF $e^{\pm}$
PHENIX
PRELIMINARY
Au+Au @$\sqrt{s_{NN}}$ = 200 GeV
p_T [GeV/c]
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
1
2
3
4
5
6
7
8
9

Suppression of Charm in Au+Au





Careful: Charmonium has not been subtracted



Method

Heavy Flavor Single Muons Penetrate the Entire Detector (gap4)

Simulate and subtract all known backgrounds

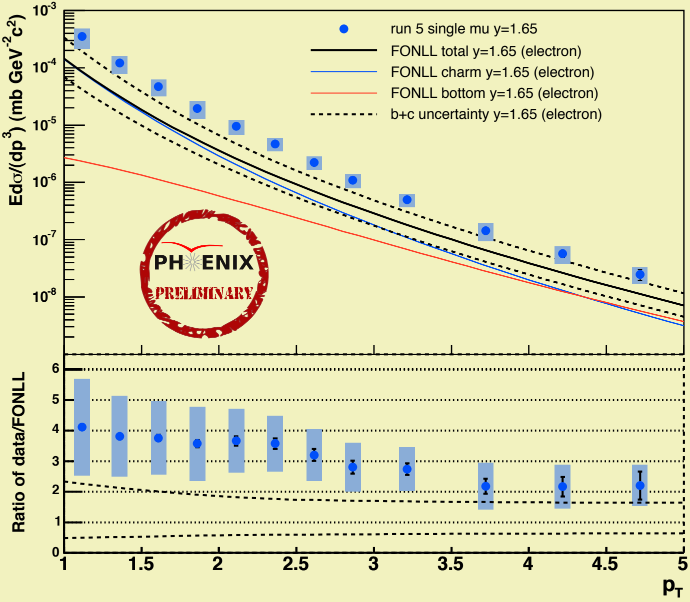
Normalize and "tune" input MC distributions by simultaneously mathching in:

- stopped hadron distributions in gaps 2 and 3
- muons from hadron decay in gap4 z-vertex distributions

Uncertainty

The largest systematic uncertainty is the hadron shower in 10λ of steel

$p + p$ Single Muon Spectrum



Method

Methodology based on the $p+p$ analysis

Refinements for Cu+Cu include:

- Simulated light hadron background cocktail embedded into real Cu+Cu data
- Additional particles in cocktail
- minor refinements

Single Muon Invariant Yield

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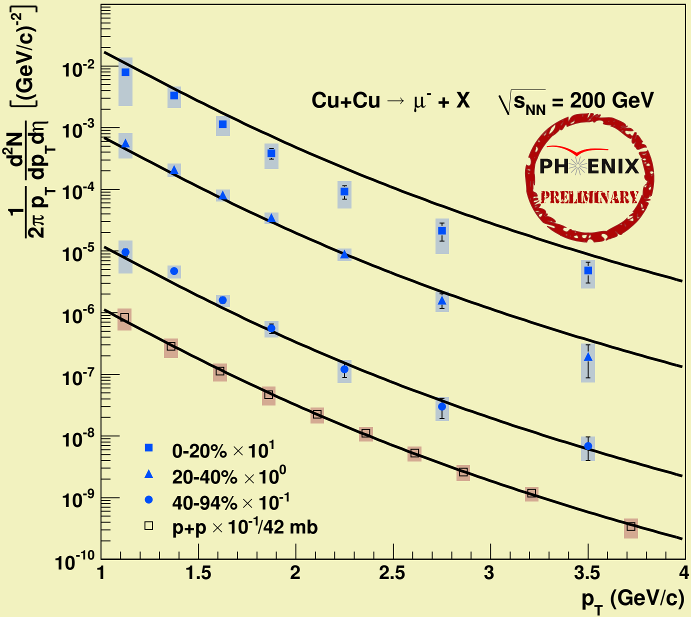
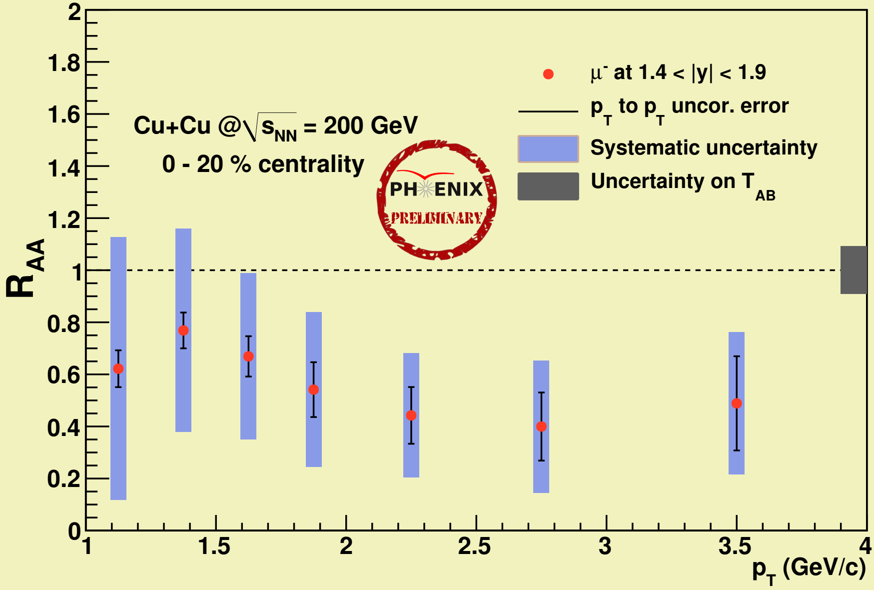
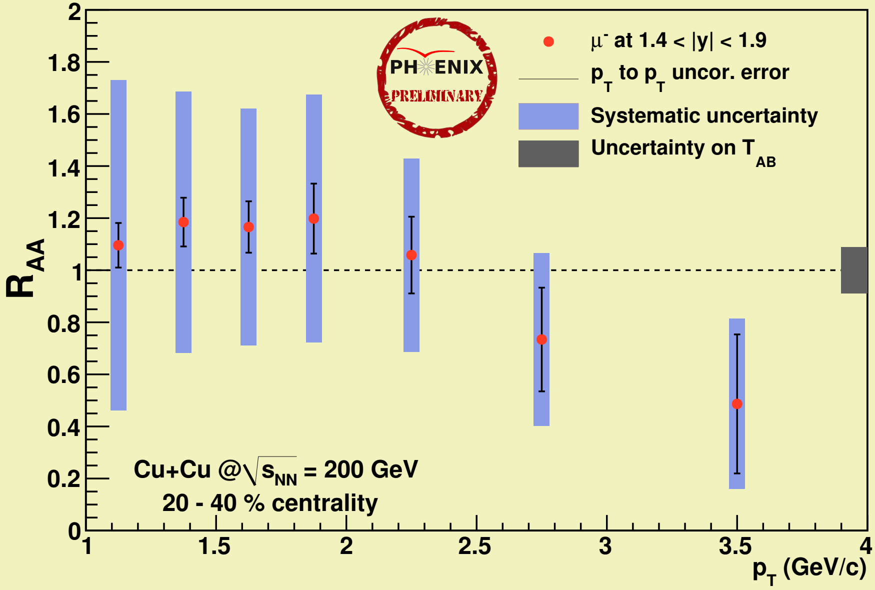
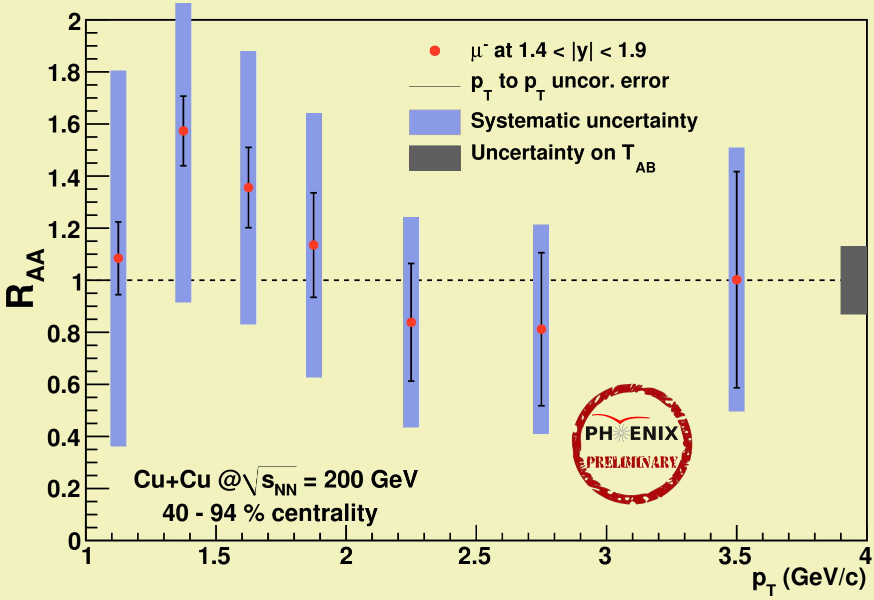


Single Muon R_{AA}

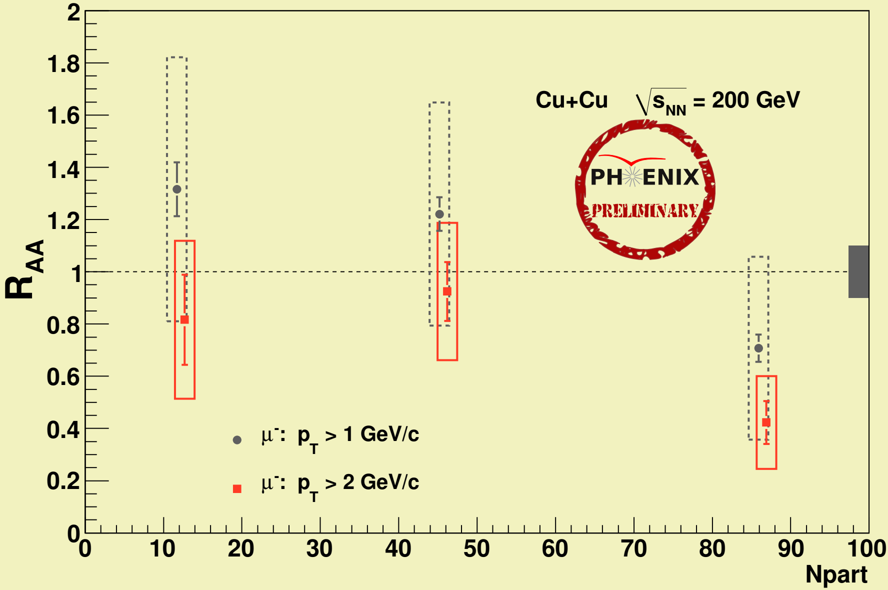



PHENIX
PRELIMINARY
μ⁻ at 1.4 < |y| < 1.9
p_T to p_T uncor. error
Systematic uncertainty
Uncertainty on T_AB
R_AA
Cu+Cu @√s_NN = 200 GeV
20 - 40 % centrality
p_T (GeV/c)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
1
1.5
2
2.5
3
3.5
4

Single Muon R_{AA}



Single Muon R_{AA}



Single Electron v_2

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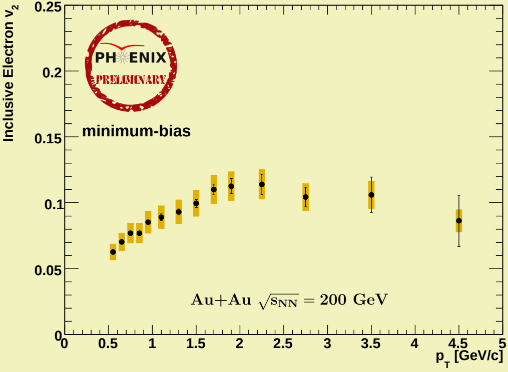
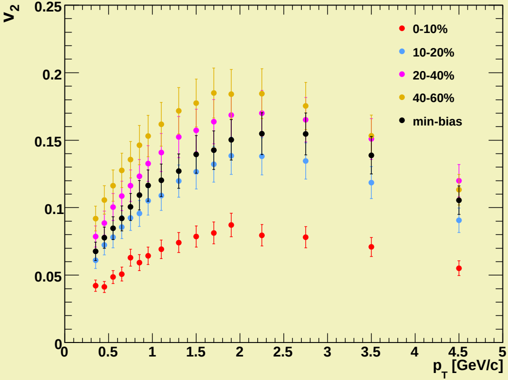
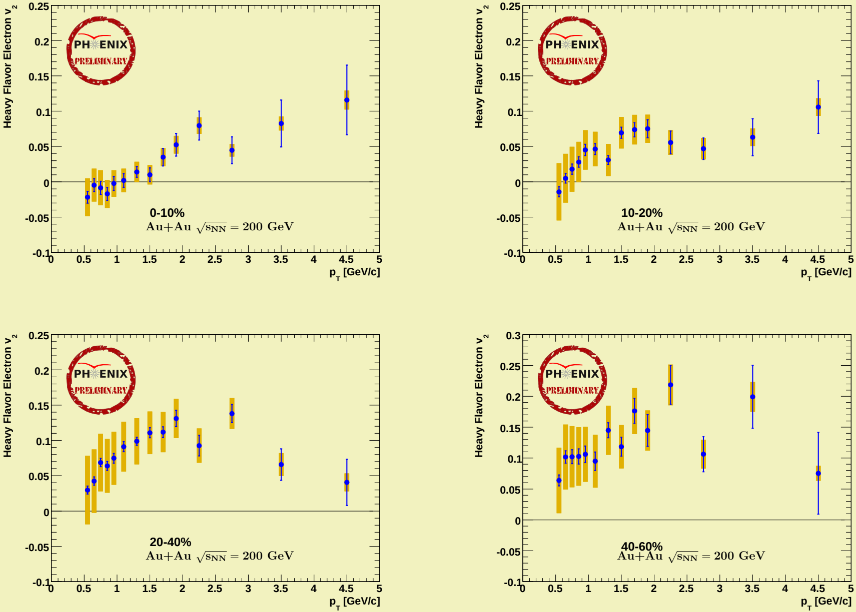


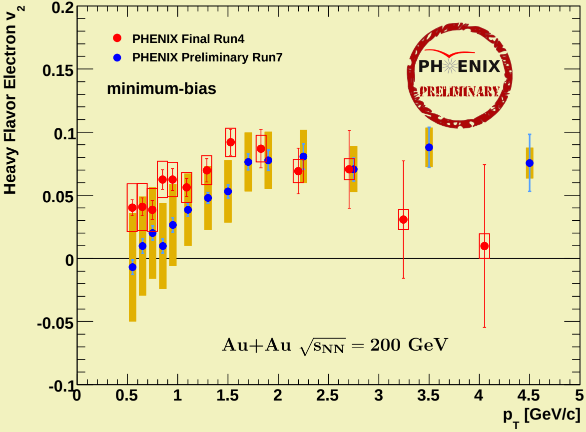


v_2 of inclusive electrons measured using the event plane from the new RXPN detector.

Cocktail for photonic electron v_2 takes measured hadron v_2 as input.

Single Electron v_2



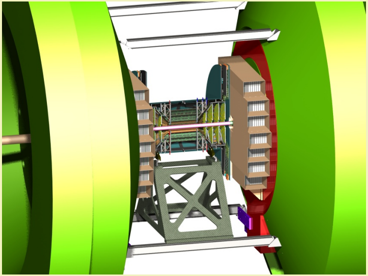


Run4 and Run7 results are complimentary: less background in Run4, better reaction plane measurement and more collisions in Run7.

PHENIX has robust heavy flavor measurements in heavy ion collisions over a large rapidity range.

J/ψ decays contribute substantially to the non-photonic electron spectrum.

Cu+Cu single muons at forward rapidity are suppressed more than electrons at mid-rapidity. This is similar to what we see for the J/ψ.



Future: Measure D and B decay by tagging displaced vertices. See posters by Alexander Lebedev and Richard Petti.

See talk later today by Tatia Englemore for more heavy flavor results at PHENIX.